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Magnetic Self-Organization in Hall-Dominated Magnetorotational Turbulence

Tuesday, 5 August 2014 10:00 (30 minutes)

The magnetorotational instability (MRI) is the most promising mechanism by which angular momentum is efficiently transported outwards in astrophysical disks. However, its application to protoplanetary disks remains problematic. These disks are so poorly ionized that they may not support magnetorotational turbulence in regions referred to as "dead zones". While purported dead zones have captured the attention of disk theorists for nearly 20 years, there is generally no consensus regarding whether they are, in fact, dead. The problem is complicated by two non-ideal MHD processes – ambipolar diffusion and the Hall effect – the latter having been largely ignored in numerical studies of the MRI until recently. In this talk, I will present several surprising results on how these effects are likely to modify the magnetic and turbulent behavior of protoplanetary disks. With a focus on models of unstratified disks dominated by a vertical magnetic flux, I will show that the Hall-MRI can saturate by producing large-scale, long-lived, axisymmetric structures in the magnetic field that cause a steep reduction in turbulent transport and instigate dust-corralling zonal flows. Ambipolar diffusion provides a field-strength-dependent diffusivity, which causes these zonal flows to "breathe" at a predictable frequency. A subsequent talk by Geoffroy Lesur will focus on stratified disks, in which a net azimuthal magnetic flux is produced and dominates the dynamics. Our results call into question contemporary models of layered accretion.

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